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The Peka, or Fruit Bat (*Pteropus tonganus tonganus*) (Mammalia, Chiroptera), of Niue Island, South Pacific[1]

KAZIMIERZ WODZICKI[2] AND HEINZ FELTEN[3]

ABSTRACT: The identification of the peka, or fruit bat, of the genus *Pteropus* from Niue (= Savage) Island (19° S, 169° W, 480 km east of Tonga, 500 km southeast of Samoa and about 1,040 km west of the Southern Cook Islands), South Pacific, by Günther (1874) as *Pteropus tonganus* Quoy & Gaimard, 1830, is confirmed.

Upon comparing the peka, the only fruit bat on Niue, with the other *Pteropus* species present on the nearest islands of Tonga, Fiji, Samoa, and Uvea, we concluded that the differences between *Pteropus samoensis* and *P. nawaiensis* are insignificant and that the latter is a subspecies of *P. samoensis*.

The present distribution, numbers, roosting and feeding habits, and present status of *Pteropus tonganus* on Niue Island are described.

THERE IS ONLY ONE TYPE of large fruit bat reported from Niue Island (=Savage Island, South Pacific), where it is known locally as "peka." The only previously published examination of peka is that of Günther (1874), who considered the one (immature) specimen available to him as being "identical with the species figured by Quoy and Gaimard in the 'Voyage of the Astrolabe' under the name of *Pt. tonganus*." Günther stated, however, that "the dentition of our example does not agree with the figure given by the French naturalists." Quoy and Gaimard (1830) cited the origin of their figured material as "Tonga-tabu," in the Tonga Island Group.

Andersen (1912) listed the specimen examined by Günther as *Pteropus tonganus*, without making further comment or study of other Niue material, and all succeeding authors have followed this opinion uncritically.

A more detailed comparison of additional Niue Island peka specimens with the single animal previously available, as well as with specimens of *Pteropus* from other South Pacific islands, is obviously desirable. Recently, an opportunity arose to collect and examine critically more Niuean *Pteropus* material, to determine more exactly the taxonomic status of this island form, and to clarify relationships of two other species of the genus previously named from the island groups of Tonga, Samoa, and Fiji. As there has been practically no information published on the ecology of the Niuean peka, a number of natural history observations were made on the animal, and these are also presented here.

MATERIALS AND METHODS

Niue Material

Five specimens (three males and two females) became available for study by the senior author. Table 1 provides localities, dates, and how the animals were killed, as well as estimated age, sex, and weight of these specimens. Two bats were captured when their mothers were shot and were kept in aviaries on diets of papaya and other fruits for several weeks before they were killed. The remaining three specimens were shot. Two were immature males and the third, a female, was the only full-grown adult (in the sense of Felten 1964*b*). All specimens are now in the National Museum, Wellington, New Zealand.

Ectoparasites were collected from specimens MA 1654 and MA 1655 and were preserved in

[1] Manuscript accepted 7 August, 1974.

[2] Victoria University of Wellington, Department of Zoology, Wellington, New Zealand.

[3] Forschungsinstitut Senckenberg, Frankfurt am Main, Western Germany.

TABLE 1

DETAILS OF FIVE FRUIT BATS COLLECTED ON NIUE ISLAND, SOUTH PACIFIC

NATIONAL MUSEUM OF NEW ZEALAND NO.	LOCALITY	DATE	HOW KILLED	ESTIMATED AGE	SEX	WEIGHT
MA 1654	Hago	30 Aug. 1969	chloroformed	2½ months, about ¼ or ⅓ adult size	F	89 g
MA 1655	Havaka	30 Aug 1969	chloroformed	5–6 months old	M	155 g
MA 1656	Tuaki	28 Jan 1971	shot, 12-gauge gun	not fully grown, ½ normal size	M	242 g
MA 1657	Tuaki	29 June 1971	shot, 12-gauge gun	immature	M	325 g
MA 1658	Fupiu	10 Jan 1972	shot, 12-gauge gun	adult	F	540 g

TABLE 2

MEASUREMENTS OF *Pteropus samoensis samoensis*, *Pteropus samoensis nawaiensis*, AND *Pteropus tonganus tonganus*, IN MM

	P. s. samoensis				*P. s. nawaiensis*				*P. t. tonganus*— Tonga, Uvea, Samoa, Fiji				*P. t. tonganus*,
	N	min	$\bar{x}$	max	*N*	min	$\bar{x}$	max	*N*	min	$\bar{x}$	max	Niue
Greatest length of Skull	8	57.3	60.2	64.0	3	58.4	59.4	60.7	42	60.6	63.7	68.3	61.5
Condylobasal Length	7	56.0	59.0	60.8	3	57.0	57.6	58.5	42	59.0	62.3	66.5	61.3
Width of Braincase	9	21.3	21.9	22.4	5	21.1	21.9	22.3	48	20.5	22.5	24.0	20.9
Zygomatic Width	6	33.3	34.6	36.1	5	32.0	34.1	35.0	43	31.7	34.7	39.4	—
Rostrum Width	10	15.6	16.9	17.5	7	15.0	16.4	17.8	59	15.6	17.0	18.4	17.8
C–M² (alv.)	9	20.4	22.2	23.7	6	20.1	21.2	22.6	61	22.3	23.8	25.7	24.2
Interorbital Width	10	8.3	8.7	9.5	7	7.7	8.4	9.4	56	7.2	8.0	8.9	7.1
Postorbital Width	10	6.7	7.3	8.2	7	6.6	7.1	7.8	53	5.3	6.7	8.1	6.0
Rostrum Length	10	22.0	23.4	25.0	7	22.6	23.2	24.2	58	26.0	27.4	29.8	27.2
Braincase Length	6	38.0	40.1	41.7	3	38.9	39.3	39.7	58	38.4	40.3	43.5	39.7
Orbital Diameter	9	12.1	12.5	13.0	7	11.8	12.5	13.1	52	12.2	12.9	14.1	12.4
Rostrum Length: Braincase Length			37:63				37:63				41:59		41:49
Forearm (Only Ulna)	8	125	138	143	6	120	125	135	48	133	141	150	133 (broken)

NOTE: Measurements of specimen from Niue taken by Wodzicki; all others by Felten. See Felten 1964*b* for methods of taking measurements.

70-percent alcohol; the viscera of specimens MA 1656–MA 1658 were preserved in 10-percent formalin for later study of internal parasites.

Information on various aspects of the biology of *P. tonganus* on Niue Island obtained by the senior author during his visits in 1968 (Wodzicki, unpublished) and July through September 1969 (Wodzicki, unpublished) has been supplemented by unpublished observations made by Dr. John C. Yaldwyn, National Museum of New Zealand, in 1971 and 1972. In addition, information, particularly on the distribution and feeding habits of the peka, was supplied by Mr. Samuel Tohilima of Hakupu, Niue, and Mr. Luka Tauelima of Lakepa, Niue.

Non-Niue Material

Material in Danish, Dutch, British, German, and North American institutions of the fruit bats *Pteropus samoensis samoensis*, *P. s. nawaiensis*, and *Pteropus tonganus tonganus* was examined by the junior author. Measurements of these

specimens are presented in Table 2. These specimens are now located as follows:

Pteropus samoensis samoensis: Senckenberg Museum, Frankfurt (SMF 35017, 35144-7); British Museum (Natural History) (BM 24.12.3.2, 93.11.29.1); Zoological Museum, Berlin (2944); Zoological Museum, Copenhagen (CN 2400); Rijksmuseum van Natuurlijke Historie, Leiden (cat. b).

Pteropus samoensis nawaiensis: Senckenberg Museum, Frankfurt (SMF 19532, 19832); British Museum (Natural History) (BM 56.9.4.2 [type], 56.17, 58.12.27.3 [type of *P. vitiensis*], 99.3.7.1); American Museum of Natural History (69566).

The data for the specimens of *P. t. tonganus* examined are given in Felten (1964*b*).

RESULTS

Taxonomy

Six specimens of *Pteropus t. tonganus* from Niue Island are now available: the immature specimen mentioned by Günther (1874), British Museum no. 74.3.31.1, and our five specimens (Table 1). All except our female specimen MA 1658 are immature animals, which leaves only one adult specimen for comparison with the *Pteropus* populations from the nearest groups of islands: Tonga, Fiji, and Samoa. Fruit bats from these islands are currently considered to belong to three different species:

Pteropus tonganus Quoy & Gaimard, 1830: Tonga, Fiji, and Samoa (including Uvea [=Wallis] Island).
Pteropus samoensis Peale, 1848: Samoa.
Pteropus nawaiensis Gray, 1870: Fiji.

Felten (1964*b*) and Felten and Kock (1972) gave measurements and reviewed the subspecies of *P. t. tonganus* from the whole range of this species and concluded that all the specimens of *P. tonganus* from these three groups of islands belong to the typical subspecies *P. t. tonganus*.

The species *Pteropus tonganus* on the one hand and *P. samoensis* and *P. nawaiensis* on the other are easily distinguished (measurements in mm):

1. Upper side of the tibia strongly haired. Rostrum markedly reduced (see Table 2 and Felten 1964*b*: 672) 2
1′ Upper side of the tibia naked. Rostrum not reduced ..... *P. tonganus*
2. Smaller: average forearm length 125; average condylobasal length 57.6; average alveolar length ($C-M^2$) 21.2 *P. nawaiensis*
2′ Larger: average forearm length 133; average condylobasal length 59.0; average alveolar length ($C-M^2$) 22. 2 ..... *P. samoensis*

The differences between the two forms *samoensis* and *nawaiensis* are so insignificant that we can reduce their status to one species with two subspecies: *Pteropus samoensis samoensis* from Samoa and *Pteropus samoensis nawaiensis* from Fiji.

The species *Pteropus samoensis* is closely related to *P. anetianus* (Gray) from the New Hebrides, Banks, and Torres islands (see Felten 1964*a* and Felten and Kock 1972), but the broad inner basal ledges in the teeth P_4, M_1, and M_2, which are strongly developed in *P. anetianus*, are only poorly or not at all developed in *P. samoensis*.

Table 2 shows the measurements of selected *Pteropus* specimens from Tonga, Fiji, and Samoa. A comparison of these measurements with those of the single adult specimen from Niue shows beyond a doubt that that specimen represents *P. t. tonganus*. Our adult specimen is similar to the living specimen shown in Figure 2. The back, rump, breast, and body are blackish, slightly darker, and glossy on the back. The mantle is very pale cream-buff, with the sides of the neck slightly deeper in shade. The foreneck is blackish, clouded with seal-brown. The head between the ears is similar in color to the mantle and mixed with brown around the ears, but the crown and temporal region are mottled light brown. The space around the eyes is pale russet and the chin and throat are blackish. The tibia is naked.

The dentition of our specimen closely resembles that figured in Quoy and Gaimard (1830) and thus does not show the differences suggested by Günther (1874).

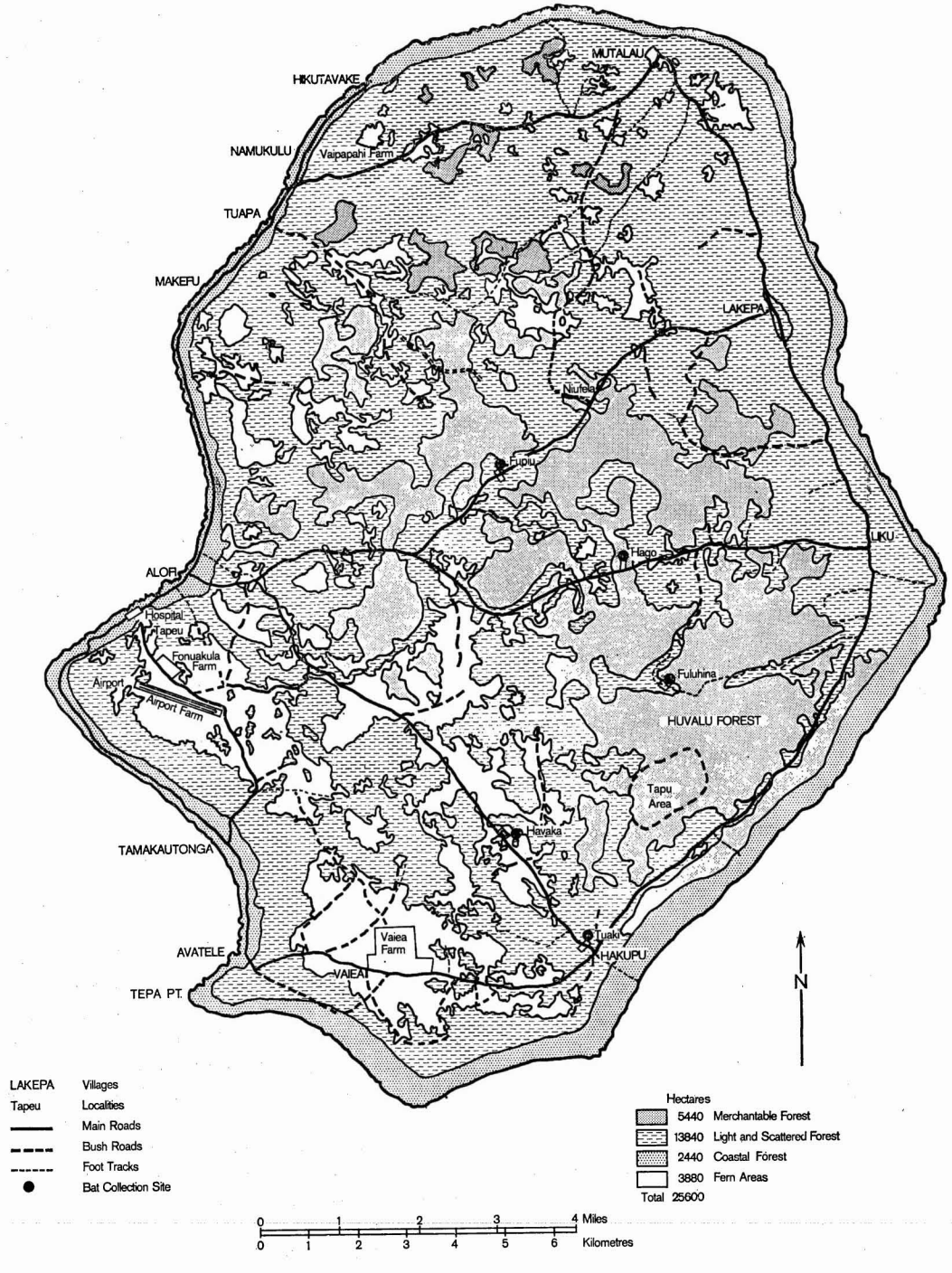

FIGURE 1. Map of Niue Island.

FIGURE 2. Peka (*Pteropus tonganus tonganus*). Captive, full-grown male specimen, Alofi, Niue Island, August 1971. Photograph by F. C. Kinsky.

ECOLOGY

Present Distribution and Roosting Habits

The Tapu Forest Sanctuary north of Hakupu Village is at present the main roosting place of the peka; all five of our specimens were collected (Figure 1) within 7 km of Tapu Sanctuary. At times the bats are known to roost outside the Tapu area but, according to Mr. Samuel Tohilima, "do not stay away long" from that area and the surrounding largest remnant of primeval forest, known as the Huvalu Forest. At present peka are not known to roost in the coastal forest, still relatively well preserved on the slopes between the lower and upper terraces of the island. However, a former roost reported by hunters as having been at Tepa Point near Avatele (Figure 1), but which was blown down by the 1960 hurricane, indicates that peka distribution also extended into the belt of coastal forest.

According to Mr. Tohilima, peka, in selecting roosts, show some preference for certain tree species: most of the roosts observed were on kanumea (*Planchonella torricellensis*), ovava (*Ficus prolixa*), and kolivao (*Syzygium richii*). However, peka are known to occupy roosts in other trees when any of the above trees are not available. The height at which the bats roost varies, but normally peka roost at heights from about 10 meters up to the topmost branches, at 25 to 35 meters.

Peka seem to return to roost on the individual trees but have been reported to change the location of a roost during the year. If disturbed, peka abandon the roost, which then may not be reoccupied from 5 to 10 years. The roosts, particularly if they have been occupied for a month or longer, are often detectable by a strong smell emanating from the site. The surest guide to a bat roost, however, is the chattering noise made by the bats, which one can often hear during the day. This was the way a party, including Dr. Yaldwyn (personal communication), located a roost with several bats hanging in upper branches during a visit to the Tapu Forest Sanctuary on 16 June 1971. The intense activity shown by these bats, all fully grown, squabbling and flying round, was attributed by the Niueans in the party to the breeding season at about this time of the year.

On Niue *P. tonganus* has been reported to roost either singly, in pairs, or in larger groups. Parties from 20 to 100 are rare and found only in the Tapu Sanctuary. In many years of peka hunting Mr. Tohilima has only once found a roost with as many as about 200 bats; the animals then were roosting on a kanumea tree.

Feeding Habits

The feeding by peka on kafika (*Syzygium inophylloides*) flowers and tava (*Pometia pinnata*) fruit has been reported by Sykes (1970). The main foods of peka according to the observations reported by the brothers S. Tohilima and L. Tauelima are listed in Table 3. The food consists of flowers and fruit, and can be divided into two main groups: favored ("high preference") foods and foods taken when favored foods are unavailable ("low preference").

TABLE 3

MAIN FOODS OF THE PEKA ON NIUE

PLANT	PREFERENCE	
	FLOWER	FRUIT
Mango, *Mangifera indica* (Anacardiaceae)	*	high
Pao, *Ochrosia oppositifolia* (Apocynaceae)	*	high
Kapok, *Ceiba pentandra* (Bombacaceae)	high	*
Kieto, *Diospyros samoensis* (Ebenaceae)	*	low
Breadfruit or Mei, *Artocarpus altilis* (Moraceae)	*	low
Ovava, *Ficus prolixa* (Moraceae)	*	low
Tuale, *Syzygium clusiifolium* (Myrtaceae)	high	low
Kafika, *Syzygium inophylloides* (Myrtaceae)	high	*
Kolivao, *Syzygium richii* (Myrtaceae)	high	low
Ifi, *Inocarpus fagiferus* (Papilionaceae)	*	high
Tava, *Pometia pinnata* (Sapindaceae)	*	high
Kanumea, *Planchonella torricellensis* (Sapotaceae)	high	high
Tomato, *Lycopersicum esculentum* (Solanaceae)	*	high
Banana or Fusi, *Musa nana* and *Musa paradisiaca* (Musaceae)	*	high
Fa, *Pandanus* spp. (Pandanaceae)	*	high

NOTE: The plant species are arranged taxonomically according to Sykes (1970) and are graded according to low or high preference.

* Either food is not eaten or no information is available.

TABLE 4

PEKA FOOD THROUGHOUT THE YEAR

PLANT SPECIES	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Syzygium spp.			*	*	*	*	*	*	†	†	†	†
Tava, *Pometia pinnata*	*	*	*	*								
Ifi, *Inocarpus fagiferus*	*	*	*	*								
Pao, *Ochrosia oppositifolia*	*	*							†	†	†*	*
Mango, *Mangifera indica*	*	*	*	*								*
Breadfruit, *Artocarpus altilis*	*	*	*	*								*
Fa, *Pandanus* spp.	*	*	*	*	*	*	*	*	*	*	*	*
Ovava, *Ficus prolixa*	*	*	*	*	*	*	*	*	*	*	*	*
Tomato, *Lycopersicum esculentum*			*	*	*	*	*	*	*	*	*	
Kautonga or Guava, *Psidium guajava*			*	*	*	*						
Banana or Fusi, *Musa nana* and *Musa paradisiaca*	*	*	*	*	*	*	*	*	*	*	*	*

* Fruit.

† Flower.

The above list of the main foods was submitted to Mr. William R. Sykes, Botany Division, Department of Scientific and Industrial Research, for comment. While Mr. Sykes generally agreed with the list of foods and preferences as shown in Table 3, he suggested (personal communications, 24 February and 1 April 1971) that two more native species, the moota (*Dysoxylum forsteri*, Meliaceae) and pua (*Fagraea berteriana*, Loganiaceae) "may well be eaten." Among introduced plants fekakai (*Syzygium malaccense*) and kautonga, or guava (*Psidium guajava*, Myrtaceae) may also be taken by the fruit bats, according to Mr. Sykes.

Mr. Sykes also made some suggestions regarding the availability of various peka foods throughout the year. These are listed, though tentative, in Table 4; it would appear that: (1) trees of the genus *Syzygium* (such as tuale, kafika, and kolivao) appear to supply the most important food in blossom and fruit throughout most of the year; (2) various cultivars of

banana, tomato, and the common guava may in combination provide an alternative food supply throughout most of the year; and (3) between May and August peka may face a natural food shortage and raid banana plantations.

Breeding Season

A female with a fetus was taken by Mr. Tohilima on 12 June 1971 (Dr. Yaldwyn, personal communication). This observation and the estimated age of the immature bats available to us (Table 1) would place the breeding season sometime between March and June; i.e., shortly after the appearance of their favored food such as the fruits of *Syzygium* trees (Tables 3, 4).

Parasites

Both ecto- and endoparasites presently are being examined and will be the subject of a separate paper.

Past and Present Status

Famines due to the frequent long droughts that occur periodically on Niue (Loeb 1926: 111) stress the importance of birds and peka as an additional supply of human food in the form of animal protein. The existence of several tapu (protected) areas—the largest area being occupied by indigenous primeval forests—and the hunting of bats with only native weapons probably resulted in a relatively stable peka population in pre-European times.

Brenchley's (1873) observation of "a great bat" flying at considerable height during daylight may imply that peka was at that time common. A nocturnal species such as peka would normally start feeding at dusk, and earlier feeding activity could possibly indicate a larger population of this species at that time.

During Smith's (1902: 24) residence on Niue at the turn of the century, peka were considered "common, and large flocks of them are sometimes seen flying overhead." Peka were still abundant in the midtwenties, when, according to Loeb (1926: 111), one night's catch "amounted to as many as fifty, seventy and even a hundred and fifty."

The dwindling area of primeval forest, the reduction from several tapu areas to one (just north of Hakupu, see Figure 1), and the introduction of shotguns were important factors that led to a drastic reduction of peka on Niue. In addition, the Wildlife Regulations 1916 (*New Zealand Gazette*, no. 72, 29 June 1916) stated that "nothing in these regulations shall be deemed to prohibit the destruction of the flying mammal known as flying foxes."[4] The implication that peka was a noxious pest contributed to a further decline in their population.

That the population of peka is now at a very low level is illustrated by the fact that the senior author, during two extended visits to Niue in 1968 and 1969 (Wodzicki, unpublished), did not observe bats flying at any time.

A new Wildlife Ordinance 1972 (*Niue Island Gazette*, no. 3/72, 14 June 1972), recently passed by the General Assembly of Niue, now prohibits shooting of "flying foxes" altogether. It is too early to gauge the effect that total protection will have on the peka population of Niue Island.

DISCUSSION

Ecology

Peka on Niue Island seem to be restricted at present to the Tapu Forest Sanctuary and surrounding Huvalu Forest (Figure 1). The location of the roosts and the food habits of peka show its dependence on the blossom and fruit of dominant trees, particularly those of the genus *Syzygium*, and also suggest how well peka was adapted to the tall, primeval forest of pre-European Niue. The depletion of this forest during the last century, and, more particularly, during the present one is no doubt an important factor in the considerable reduction of the areas now occupied by this species as well as in its present reduction in numbers. Of equal, if not greater, importance was the introduction and the liberal licensing of firearms on the island. The existence of the Tapu Sanctuary near Hakupu has been and still is the major factor that has prevented the extinction of peka on Niue. The understanding of the principles of nature conservation by the General Assembly

[4] Local (English-language) term for large fruit bats.

of Niue, as shown by the adoption of the Wildlife Ordinance 1972, is an important step toward the preservation of the peka. There is a reasonable hope that the downward trend of the population of peka will be arrested and their numbers will begin to increase.

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